

## **Russian Operational Considerations**

The following information describes the expected Bion-M1 operations flow and special considerations for working in Russia. This information is based on past Bion and Foton lessons learned and serves as a general guide for preparing the operational and logistical considerations of the Bion-M1 NRA proposal. Due to the dynamic nature of conducting scientific payload activities in Russia, the necessity of real-time changes during travel and operations may occur.

### **Purchasing and Transportation of equipment, materials, chemicals, and animals to Russia**

The purchase and receipt of specialized equipment, hazardous chemicals, perishable or difficult to obtain reagents, and general supplies in Moscow is very difficult for both international and resident scientists. The process can be very time consuming, which may result in delays to the start of activities. If there is an item that must be purchased in Russia, the Bion-M1 team will work with each selected investigator to assess the possibility of procuring it in Moscow or purchasing and shipping it from the U.S. or Europe.

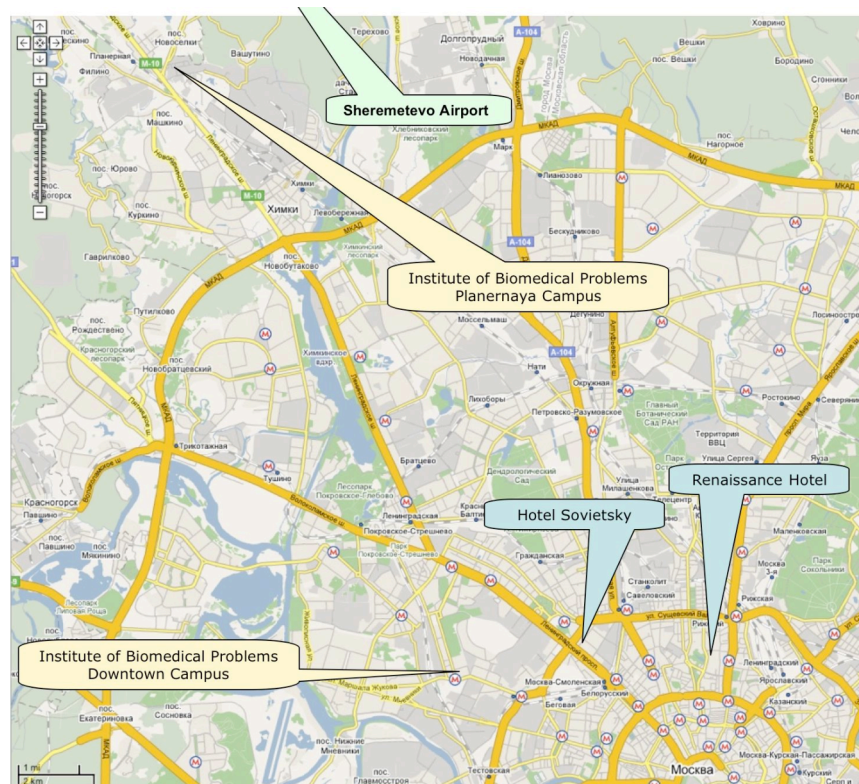
To reduce this risk of failing to have the required equipment and supplies in place when needed, the best options are either to ship the required equipment, supplies, and reagents to Moscow from the home institution of the Investigator or to ship them directly from the supplier to Moscow. If shipped from the investigator's institution, it is critical that the Investigators verify that the items are packed per U.S. Department of Transportation (D.O.T.) requirements and Russian importation requirements. This includes appropriate shipping containers and labels. Furthermore, all of the required customs documents, permits, and other support documentation for importation into Russia must be completed and provided with the shipment. Also, the Investigator must certify that all items being shipped from the U.S. do not violate U.S. restrictions on transferring goods, technologies, or biological agents into Russia. Items that have proven to be extremely difficult to pass Russian customs in the past are hazardous goods, including toxic reagents, infectious agents, and biological specimens. Delays in getting shipments through customs are not unusual due to the intensive nature of the process, the potential for real-time changes in the Customs approval process, or additional paperwork requirements. These delays can be especially problematic when the items being shipped are temperature sensitive, volatile, or otherwise time sensitive.

In developing the pre-flight and post-recovery processes, the Investigator should consider the procurement and shipping risks when identifying which supplies, reagents, and equipment will be needed on-site. The Investigator should consult with the Certified/Trained D.O.T. Shipping representative at their institute to obtain information about export and import regulations for the U.S. and Russia. For items that may result in Customs approval delays or procurement problems but are absolutely required for operations in Moscow, these items must be identified very early in the mission development process so that the Bion-M1 team can begin working the issues as early as possible. The same caveats also apply to animals, especially genetically modified animals.

The Bion-M1 team will work with each selected investigator to assess the possibility of procuring supplies in Moscow or, as a fallback, shipping supplies from the U.S. or Europe, including biological specimens. The team will also work to consolidate requirements where this will not impact the science of the Investigator.

## Operations in Moscow

In developing the travel aspects of the proposal, the investigator should keep in mind that Moscow is a very expensive city for travelers, and the room rates for most of the hotels are far above the government per diem allowance. Also, the ability to get around Moscow can be very difficult due to heavy traffic congestion. It is not unusual for it to take exceedingly long times (hours) to travel a few miles. Based on past experience, the Hotel Sovietsky is recommended for both cost and logistical considerations. The Renaissance Hotel has been used in the past, but the travel times to and from this hotel from the laboratory campuses can be excessively long. The map of Moscow in Figure 1 shows the location of these hotels and Institute of Biomedical Problem (IMBP) campuses.

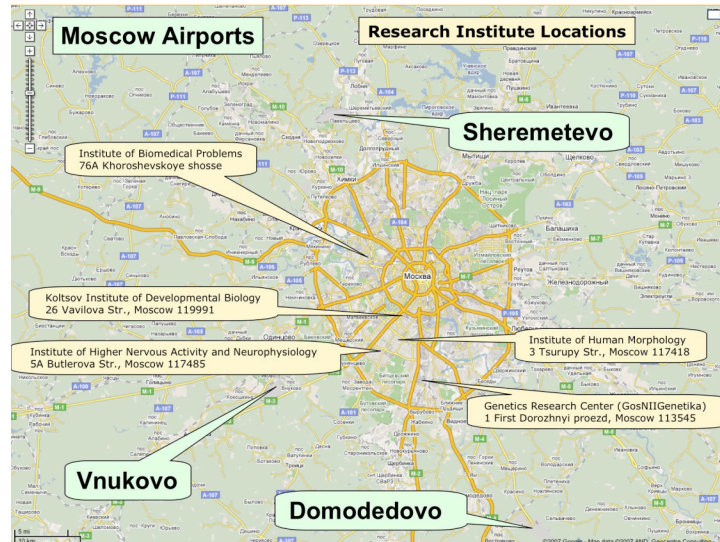


**Figure 1 - Moscow Lodging and IMBP Locations**

Animal work can be conducted at either of the IMBP campuses shown on the map. However, based on Bion-M1 team past experience, the travel time to the IMBP Planernaya campus from the listed hotels or the IMBP downtown campus can take several hours. The Moscow Metro is an obvious alternative to traveling the streets, which can be used when it is feasible. However, depending on circumstances, transportation by the Metro is not always prudent. There is no Metro service to the IMBP Planernaya campus.

The information concerning cost of hotels and traveling around Moscow were provided to emphasize the fact that conducting operations in the city requires a great deal of careful pre-planning and flexibility from all Project teams in order to reduce risks to conducting pre-flight processing and post-flight recovery operations.

The map in Figure 2 shows the location of institutes that have been used in the past for laboratory activities. Currently, the institute that will support Bion-M1 operations has not been determined. It is possible that one or more of these institutes will be used. The quality of the laboratory facilities can vary between each institute and within an institute. The Investigator can contact Dr. Richard Boyle (Bion-M1 Project Scientist) for information on laboratory conditions at the institutes. Also, he can provide contact information for other scientists who have experience working in Moscow.



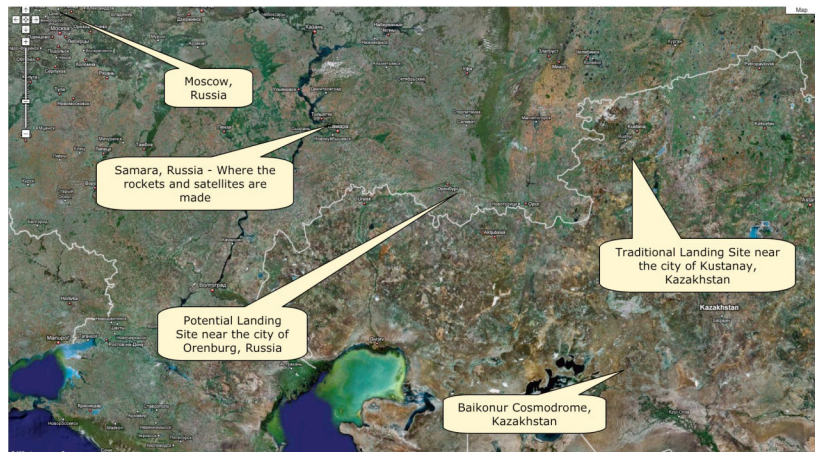
**Figure 2 - Foton-M3 Operational Locations in Moscow**

It is expected that most engineering and science developmental testing will take place in Moscow, at the Institute for Biomedical Problems (IMBP) and will culminate in up to three Joint Bioengineering Tests (JBETs). Nominally, each JBET is planned in conjunction with the delivery of prototype, flight prototype, and flight hardware. Each JBET will be an opportunity to examine scientific procedures, verify hardware function, and to reevaluate and refine the mission plans. The final JBET will be a full fidelity mission length simulation. It is expected that the JBET testing will be a significant resource to develop comparative ground reference data.

### **Transport from Moscow to Baikonur Cosmodrome**

IMBP, the overall payload management institute for Bion-M1, is currently planning that all the animals and hardware will be transported from Moscow to Baikonur Cosmodrome via passenger train. This same method was used in the past for mammals launching from the Plesetsk Cosmodrome. The trip takes approximately 1.5 days. The map in Figure 3 shows the location of the Russian Space Agency sites and travel distances.





**Figure 3 - Operational Locations – Russia and Kazakhstan**

### **Operations at Baikonur Cosmodrome**

Bion-M1 will be the first set of NASA fundamental biology payloads to launch out of the Baikonur Cosmodrome. Since this is the first flight from this location, there is very little knowledge of the facility for supporting payloads. It is understood that at least one room, if not more, will be provided to prepare the NASA payloads. The physical state of the processing room is not known. The Bion-M1 team wants to arrange a visit to Baikonur Cosmodrome before the flight to tour the facility and obtain an understanding of the operational environment. Travel to Baikonur will be by train, only. It is known that the Bion-M1 team will need to bring everything needed for operations at Baikonur on the train, without exception. This requirement applies to all personal items, laboratory supplies, chemicals, biologicals, and equipment. There will be absolutely no shipping capability to the Cosmodrome. All items must be easily carried onto and stowed on the train in the passenger compartment in a manner that facilitates ease of identification and removal from the train at the Baikonur or Moscow train station.

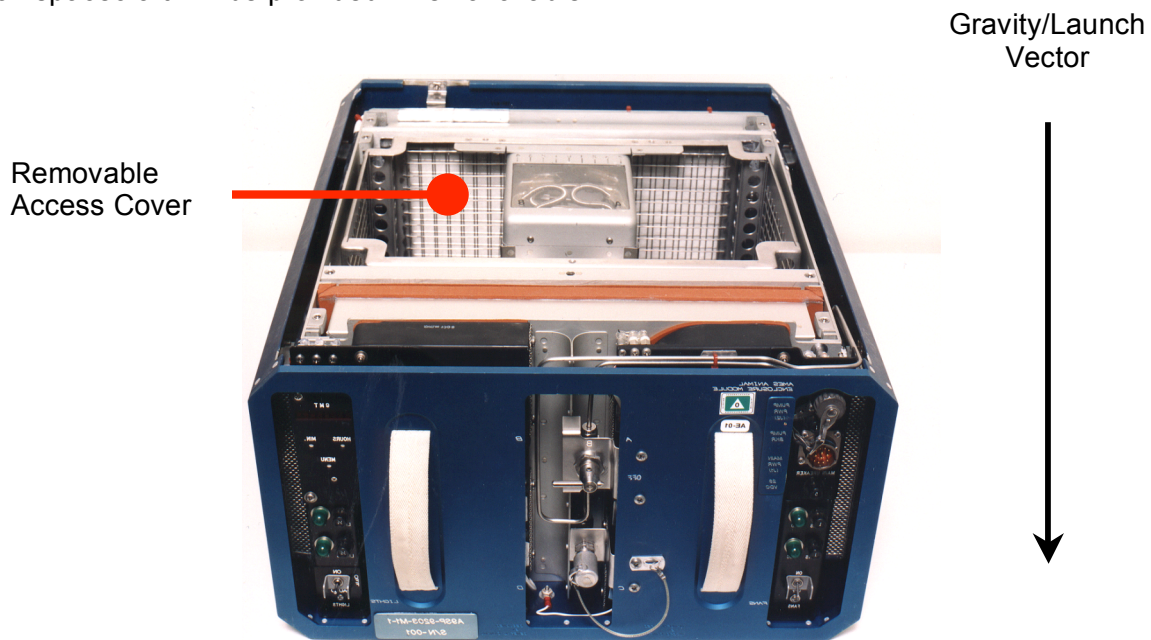


**Figure 4 - Foton-M3 Preparation at Baikonur Cosmodrome**



For proposals involving the use of infectious agents, the safety aspects of these agents must be thoroughly considered, as well as import and export regulations as stated above. The AEMs can not contain biological agents (bacteria and virus). Of course our primary concern is human exposure during preflight handling, AEM loading, AEM unloading at recovery, and then transport back to Moscow. Also, the consideration for any cross-contamination between in-flight payloads must be assessed.

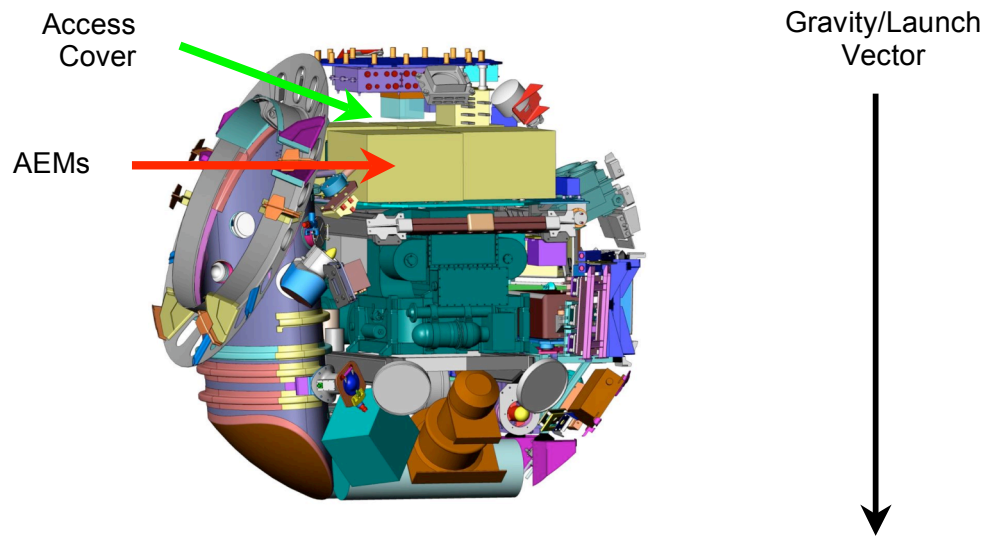
The payloads will be loaded into the spacecraft between 60 to 72 hours before launch. The standard orientation of the AEM during animal load is with the removable access cover facing up (see Figure 5). During most of the time on the pad and at launch, the orientation of the AEM is with the removable access cover facing up. This results in a launch g vector direction that is perpendicular to the cover, which is the same direction as the Gravity vector when the AEM is on the pad (see Figure 5). The AEM shown in Figure 5 is the Space Shuttle version. The Blon-M1 AEM is currently undergoing modifications, and a separate document that describes the approach to modifying the AEM for flight on the Bion spacecraft will be provided when available.



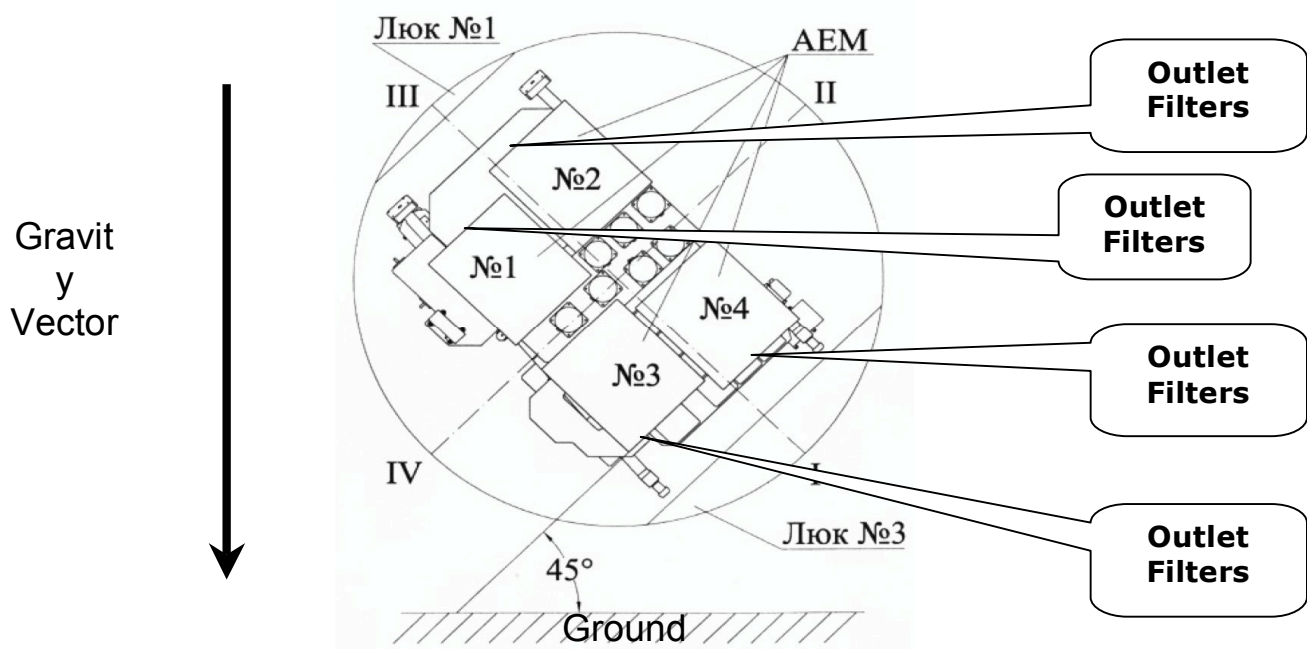
**Figure 5 - Example of the AEM Orientation On the Pad and at Launch (AEM Space Shuttle version)**

The illustrations in Figures 6A and 6B show other views of the AEMs post loading into the Bion capsule and the orientation of the AEMs during the rollout process. The rocket rollout is shown at the top left of Figure 4 entitled “Foton-M3 Preparation at Baikonur Cosmodrome”

NASA travel to the launch site will be limited to a small team who will perform the final preparations or flight.



**Figure 6A - AEMs in Bion Launch Configuration**



**Figure 6B - AEMs in Bion Rollout Configuration**

### **Recovery Operations**

The Bion recoverable capsule undergoes a ballistic reentry and thus has a fairly large potential touchdown "footprint". Typically the recovery site is not near populated areas and thus everything needed for the recovery operation must be brought in on helicopters. Images from the Foton-M3 recovery operations are shown in Figure 7.



**Figure 7 - Foton-M3 Recovery**

Since the recovery on Bion-M1 is now scheduled for 1 November 2010 there is a possibility that the recovery environment may be more like that of Bion-11 (1996; see Figure 8), with cold temperatures and snow. It is not clear at this time if IMBP still has the capability to provide an inflatable structure (see Bion-11 images) at the recovery site or if there are other possibilities to mitigate weather issues during the recovery process. An assessment of the RSA/IMBP recovery process is currently in progress, and further information will be provided as it becomes available.

It is readily apparent from these images that the landing site capabilities with regard to payload processing are severely limited and that the presence of infectious agents would clearly present safety concerns.

After recovering the AEMs from the capsule, the plan is to transfer the animals to a more suitable transport cage for return to Moscow. This involves helicopter transport to a nearby airfield, air transport to Moscow, and finally, ground transportation to the Moscow laboratories. For reference the elapsed time from recovery to the Moscow labs have been: Bion-11  $\approx$  13 hours, Foton-M2  $\approx$  30 hours, and Foton-M3  $\approx$  13.5 hours. The Bion-M1 team will be doing everything it can to make the recovery to Moscow time as short as possible.

If NASA support at the recovery site is made available, the team that travels will be strictly limited to those who must support recovery operations.





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**Figure 8 - Bion-11 Recovery**

### **Getting equipment, materials, and animals out of Russia**

In order to ship items out of Russia, every shipment must comply with Russian shipping regulations for packing, labeling, and documentation as well as with those of the U.S. Also, the shipped package must comply with the applicable import customs regulations of the U.S., including provision of all shipping documents and permits. The Investigator must plan for unexpected delays at the Russian exit point, so it will be necessary for all samples exiting Russia to be in a stable condition prior to initiating the shipment. The Bion-M1 team will work with investigators on a case-by-case basis to where biological samples must be returned to the US for further analysis.